Contents

Chap	ter 1	Geotechnical Operations and Administration	
1.1	Scope 1.1.1 1.1.2 1.1.3	of Geotechnical Design, Construction, and Maintenance Support Geotechnical Design Objectives for Project Definition Phase Geotechnical Design Objectives for Project Design Phase Geotechnical Design Objectives for PS&E Development Phase	1-1 1-2 1-2 1-3
1.2		of Offices Providing In-House Geotechnical Design, Construction, and enance Support Lead Role for WSDOT Regarding Geotechnical Policy and Design Geotechnical Functions Delegated to the Regions Coordination between HQ's and Region Regarding Emergency Response	1-3 1-3 1-5 1-8
1.3	Geote 1.3.1 1.3.2 1.3.3 1.3.4 1.3.5 1.3.6 1.3.7	chnical Support within the WSDOT Project Management Process (PMP) Initiate and Align Plan the Work Endorse the Plan Work the Plan Transition and Closure Application of the PMP to Construction Master Deliverables to be Considered	1-10 1-10 1-11 1-11 1-12 1-12 1-13
1.4	Geote 1.4.1 1.4.2	chnical Report Review Process, Certification and Approval Requirements Report Certification Approval of Reports Produced by the HQ Geotechnical Division	1-15 1-16 1-17
1.5		ts Produced by Consultants or other Agencies for WSDOT, and Reports ced by Design-Builders	1-17
1.6	Geote	chnical Consultant Administration	1-18
1.7	Geote 1.7.1 1.7.2 1.7.3	chnical Information Provided to Bidders Final Geotechnical Project Documentation Final Geotechnical Documentation Publication Geotechnical Information to be Included as Part of the Contract	1-21 1-21 1-21 1-22
1.8	Samp	le Retention and Chain of Custody	1-22
1.9	Geote	chnical Design Policies and their Basis	1-23
1.10	Geote 1.10.1		1-24
	1.10.2	Bid-Build Projects Division of Responsibilities for Construction Support of Design-Build Projects	1-24
	1.10.3	<u> </u>	1-26

1.11	Geotech 1.11.1 1.11.2	Proprietary Retaining Walls Other Construction Submittals (Non-Proprietary walls, Excavation and Shoring, Soldier Piles, Ground Anchors, Shafts, Piles, Ground	1-27 1-27
		Improvement, etc.)	1-27
Appe	ndix 1-A	Preliminary Geotechnical Engineering Services Scope of Work	1-29
Appe	ndix 1-B	Geotechnical Engineering Services Scope of Work for PS&E Level De	esign 1-33
Chap	oter 2 P	Project Geotechnical Planning	
2.1	Overvie	·w	2-1
2.2	Prelimir 2.2.1 2.2.2	Overview Office Review	2-1 2-1 2-2
	2.2.3	 2.2.2.10 Site Geology and Seismicity 2.2.2.20 Previous Site Exploration Data 2.2.2.3 Previous Site Use 2.2.2.4 Construction Records Site Reconnaissance 	2-3 2-5 2-6 2-7 2-7
2.3	Develor	2.2.3.1 General coment of the Subsurface Exploration Plan	2-7 2-9
2.5	2.3.1 2.3.2 2.3.3	General Considerations for Preparation of the Exploration Plan Criteria for Development Preparing the Exploration Plan	2-9 2-9 2-15
2.4	Referen	ces	2-17
Appe	ndix 2-A	Field Exploration Request Form	2-19
Chap	oter 3 F	ield Investigation	
3.1	Overvie	·w	3-1
3.2	Activiti	es and Policies – Before Exploration	3-1
3.3	Activiti	es and Policies – During Exploration	3-3
3.4	Activiti	es and Policies – After Exploration	3-7
3.5	Standar	d Penetration Test (SPT) Calibration	3-7
3.6	Referen	ces	3-7
Appe	ndix 3-A	Daily Drill Report Form	3-9
	ndix 3-B	Field Investigation Best Management Practices for Erosion and Spill Prevention	3-11
Appe	ndix 3-C	Portable Penetrometer Test Procedures	3-15

Cha	oter 4	Soil and Rock Classification and Logging	
4.1	Over	view	4-3
4.2	Soil (4.2.1 4.2.2 4.2.3 4.2.4	Organic Fine Grained Soils	4-3 4-4 4-7 4-10
Cha	oter 5	Engineering Properties of Soil and Rock	
5.1	Over	view	5-1
5.2	Influe	ence of Existing and Future Conditions on Soil and Rock Properties	5-2
5.3	Meth	ods of Determining Soil and Rock Properties	5-2
5.4	5.4.1 5.4.2 5.4.3 5.4.4	Seepage Tests Slug Tests Piezocone Tests	5-3 5-5 5-5 5-6 5-6 5-7
5.5	Labor 5.5.1 5.5.2	ratory Testing of Soil and Rock Quality Control for Laboratory Testing Developing the Testing Plan	5-7 5-7 5-9
5.6	Engir 5.6.1 5.6.2 5.6.3	Laboratory Index Property Testing Laboratory Performance Testing Correlations to Estimate Engineering Properties of Soil	5-10 5-10 5-10 5-12
5.7	Engir	neering Properties of Rock	5-14
5.8	Final 5.8.1 5.8.2 5.8.3 5.8.4 5.8.5	Selection of Design Values Overview Data Reliability and Variability Final Property Selection Development of the Subsurface Profile Selection of Design Properties for Engineered Materials	5-15 5-16 5-16 5-18 5-18
5.9	Prope 5.9.1 5.9.2 5.9.3 5.9.4 5.9.5 5.9.6 5.9.7 5.9.8	erties of Predominant Geologic Units in Washington Loess Peat/Organic Soils Glacial Till and Glacial Advance Outwash Colluvium/Talus Columbia River Sand Columbia Basin Basalts Latah Formation Seattle Clay	5-23 5-23 5-24 5-26 5-27 5-27 5-28

	5.9.9 5.9.10 5.9.11 5.9.12	Coastal F Troutdale	am Glaciomarine Drift Range Siltstone/Claystone e Formation Basalts - Crescent Formation	5-31 5-32 5-32 5-33	
	5.9.13		Rocks on Olympic Peninsula	5-33	
5.10	Referen	C	The state of the s	5-34	
Char	oter 6 S	Seismic D	esian		
6.1			esponsibility and Policy	6-1	
0.1	6.1.1	_	bility of the Geotechnical Designer	6-1	
	6.1.2		nical Seismic Design Policies	6-1	
	0.1.2	6.1.2.1	Seismic Performance Objectives	6-1	
		6.1.2.2	· ·	6-3	
		6.1.2.3	Maximum Considered Depth for Liquefaction	6-4	
	6.1.3	Governin	g Design Specifications and Additional Resources	6-5	
6.2	Geotech	nnical Seisi	mic Design Considerations	6-7	
	6.2.1	Overview	Ÿ	6-7	
	6.2.2	Site Char	racterization and Development of Seismic Design Parameters	6-8	
	6.2.3	Informati	ion for Structural Design	6-20	
6.3	Seismic Hazard and Site Ground Motion Response Requirements				
	6.3.1 Determination of Seismic Hazard Level		6-22		
	6.3.2		and Motion Response Analysis	6-28	
	6.3.3		C for Site Response	6-28	
	6.3.4		g Ground Surface Acceleration to Other Site Classes	6-29	
	6.3.5	Earthqua	ke Magnitude	6-30	
6.4	Seismic Geologic Hazards				
	6.4.1	Fault Rup		6-30	
	6.4.2	Liquefact		6-33	
		6.4.2.1	Methods to Evaluate Potential Susceptibility of Soil to		
			Liquefaction	6-35	
		6.4.2.2	Assessment of Liquefaction Potential	6-37	
		6.4.2.3	Minimum Factor of Safety Against Liquefaction	6-41	
		6.4.2.4	Liquefaction Induced Settlement	6-42	
		6.4.2.5	Residual Strength Parameters	6-45	
		6.4.2.6	Assessment of Liquefaction Potential and Effects Using	6-45	
		6.4.2.7	Laboratory Test Data Weakening Instability Due to Liquefaction	6-47	
		6.4.2.8	Combining Seismic Inertial Loading with Analyses Using	0-47	
		0.4.2.0	Liquefied Soil Strength	6-50	
	6.4.3	Slone Ins	stability Due to Inertial Effects	6-53	
	0.1.5	6.4.3.1	Pseudo-Static Analysis	6-53	
		6.4.3.2	Deformations	6-54	
	6.4.4		nt of Dry Sand	6-57	

6.5	-	r Structura	-	6-57
	6.5.1		on Springs	6-57
		6.5.1.1	Shallow Foundations	6-58
	6.5.2	6.5.1.2	Deep Foundations ke Induced Earth Pressures on Retaining Structures	6-59 6-63
	6.5.3	_	g Loads on Structures	6-63
	6.5.4		pread / Slope Failure Loads on Structures	6-64
	0.0.1	6.5.4.1	Displacement Based Approach	6-64
		6.5.4.2	Force Based Approaches	6-66
		6.5.4.3	Mitigation Alternatives	6-67
6.6	Referen	ces		6-70
Apper	ndix 6-A	Site Spec	cific Seismic Hazard and Site Response	6-75
		6-A.1	Background Information for Performing Site Specific Analysis	6-75
			6-A.1.1 Regional Tectonics	6-75
			6-A.1.2 Seismic Source Zones	6-76
		6-A.2	Design Earthquake Magnitude	6-78
		6-A.3	Probabilistic and Deterministic Seismic Hazard Analyses	6-79
		6-A.4	Selection of Attenuation Relationships	6-81
		6-A.5	Site Specific Ground Response Analysis	6-81
			6-A.5.1 Design/Computer Models	6-81
		6-A.6	6-A.5.2 Input Parameters for Site Specific Response Analysis	18 6-8 <i>3</i> 6-84
			Analysis Using Acceleration-Time Histories	0-82
-		•	oility Analysis	7 1
7.1	Overvie			7-1
7.2	-		esign Parameters and Other Input Data for Slope Stability Analys	
7.3	Design	Requireme	ents	7-2
7.4	Resistar	nce Factors	and Safety Factors for Slope Stability Analysis	7-4
7.5	Referen	ces		7-5
Chap	ter 8 F	oundatio	n Design	
8.1	Overvie	W		8-1
8.2	Overall	Design Pro	ocess for Structure Foundations	8-1
8.3	Data Ne	eded for F	oundation Design	8-5
	8.3.1		ploration Requirements for Foundations	8-7
	8.3.2	Laborato	ry and Field Testing Requirements for Foundations	8-10
8.4	Foundat	tion Selecti	ion Considerations	8-10
8.5	Overvie	w of LRFI	O for Foundations	8-12
8.6	LRFD I	Loads, Load	d Groups and Limit States to be Considered	8-13
	8.6.1		on Analysis to Establish Load Distribution for Structure	8-13
	8.6.2	Downdra	· ·	8-15

	8.6.3	Uplift Loa	ds due to Expansive Soils	8-16
	8.6.4	Soil Loads	on Buried Structures	8-16
	8.6.5	Service Li	mit States	8-16
		8.6.5.1	Tolerable Movements	8-17
			Overall Stability	8-19
		8.6.5.3	Abutment Transitions	8-20
	8.6.6	Strength L		8-21
	8.6.7	Extreme E	vent Limit States	8-21
8.7	Resistan	ce Factors f	or Foundation Design – Design Parameters	8-21
8.8	Resistan	ce Factors f	or Foundation Design – Service Limit States	8-22
8.9	Resistan	ce Factors f	or Foundation Design – Strength Limit States	8-22
8.10	Resistano 8.10.1	ce Factors f Scour	For Foundation Design – Extreme Event Limit States	8-23 8-23
	8.10.2	Other Extr	eme Event Limit States	8-23
8.11	Spread F	ooting Des	ign	8-23
	8.11.1	Loads and	Load Factor Application to Footing Design	8-24
	8.11.2	Footing Fo	oundation Design	8-27
		8.11.2.1	Footing Bearing Depth	8-28
		8.11.2.2	Nearby Structures	8-28
		8.11.2.3	Service Limit State Design of Footings	8-28
			8.11.2.3.1 Settlement of Footings on Cohesionless Soils	8-28
			8.11.2.3.2 Settlement of Footings on Rock	8-29
			8.11.2.3.3 Bearing Resistance at the Service Limit State	
			Using Presumptive Values	8-29
		8.11.2.4	Strength Limit State Design of Footings	8-29
			8.11.2.4.1 Theoretical Estimation of Bearing Resistance 8.11.2.4.2 Plate Load Tests for Determination of Bearing	8-29
			Resistance in Soil	8-30
			8.11.2.4.3 Bearing Resistance of Footings on Rock	8-30
		8.11.2.5	Extreme Event Limit State Design of Footings	8-30
8.12	Driven P	ile Foundat	tion Design	8-31
	8.12.1	Loads and	Load Factor Application to Driven Pile Design	8-33
	8.12.2	Driven for	Pile Foundation Geotechnical Design	8-35
		8.12.2.1	Driven Pile Sizes and Maximum Resistances	8-35
		8.12.2.2	Minimum Pile Spacing	8-36
		8.12.2.3	Determination of Pile Lateral Resistance	8-36
		8.12.2.4	Batter Piles	8-37
		8.12.2.5	Service Limit State Design of Pile Foundations	8-37
			8.12.2.5.1 Overall Stability	8-37
			8.12.2.5.2 Horizontal Pile Foundation Movement	8-37
		8.12.2.6	Strength Limit State Geotechnical Design of Pile Foundations	8-37
			8.12.2.6.1 Nominal Axial Resistance Change after Pile Driving	
			8 12 2 6 2 Scour	8-37

			8.12.2.6.3 Downdrag	8-39			
			8.12.2.6.4 Determination of Nominal Axial Pile Resistance in Compression	8-41			
			8.12.2.6.5 Nominal Horizontal Resistance of Pile Foundations	8-43			
		8.12.2.7	Extreme Event Limit State Design of Pile Foundations	8-44			
8.13			dation Design	8-46			
	8.13.1		d Load Factor Application to Drilled Shaft Design	8-48			
	8.13.2		haft Geotechnical Design	8-48			
		8.13.2.1 8.13.2.2	General Considerations	8-48 8-48			
		8.13.2.3	Nearby Structures Service Limit State Design of Drilled Shafts	8-49			
		0.13.2.3	8.13.2.3.1 Horizontal Movement of Shafts and Shaft Groups	8-49			
			8.13.2.3.2 Overall Stability	8-50			
		8.13.2.4	Strength Limit State Geotechnical Design of Drilled Shafts	8-50			
			8.13.2.4.1 Scour	8-50			
			8.13.2.4.2 Downdrag	8-51			
			8.13.2.4.3 Nominal Horizontal Resistance of Shaft and	0.51			
		0 12 2 5	Shaft Group Foundations	8-51			
0.4.4		8.13.2.5	Extreme Event Limit State Design of Drilled Shafts	8-52			
8.14	Micropi	les		8-52			
8.15	Propriet	ary Founda	ation Systems	8-52			
8.16	Detention Vaults						
	8.16.1	Overview		8-53			
			estigation Requirements	8-53			
	8.16.3	_	equirements	8-54			
8.17	Referen	ces	tes 8-				
Chap	ter 9 E	mbankme	ents				
9.1	Overvie	w and Data	n Needed	9-1			
	9.1.1	Site Reco	nnaissance	9-1			
	9.1.2		loration and Laboratory Testing Requirements	9-2			
	9.1.3		pling and Stratigraphy	9-3			
	9.1.4	Groundwa	ater	9-5			
9.2	_	Considerati		9-6			
	9.2.1	<i>2</i> 1	mbankment Materials and Compaction	9-6			
		9.2.1.1	Rock Embankments	9-6			
		9.2.1.2 9.2.1.3	Earth Embankments and Bridge Approach Embankments Fill Placement Below Water	9-7 9-8			
	9.2.2		nents for Detention/Retention Facilities	9-8			
	9.2.3		Assessment	9-9			
	, .	9.2.3.1	Safety Factors	9-9			
			Strength Parameters	9-10			

	9.2.4	Embankr	Embankment Settlement Assessment		
		9.2.4.1	Settlement Impacts	9-11	
		9.2.4.2	Settlement Analysis	9-12	
			9.2.4.2.1 Primary Consolidation	9-12	
			9.2.4.2.2 Secondary Compression	9-13	
		9.2.4.3	Stress Distribution	9-13	
			9.2.4.3.1 Simple 2V:1H Method	9-13	
			9.2.4.3.2 Theory of Elasticity	9-14	
			9.2.4.3.3 Empirical Charts	9-15	
			9.2.4.3.4 Rate of Settlement	9-16	
		9.2.4.4	Analytical Tools	9-17	
9.3	Stabilit	y Mitigatio	n	9-17	
	9.3.1		onstruction	9-17	
		9.3.1.1		9-19	
		9.3.1.2	In-Situ Shear Strength and Determination of Stability A		
			Undrained Loading	9-20	
		9.3.1.3	Total Stress Analysis	9-22	
		9.3.1.4	Effective Stress Analysis	9-26	
	9.3.2		forcement	9-28	
	9.3.3	Ground I	mprovement	9-29	
	9.3.4	Lightwei		9-30	
		_	Geofoam	9-30	
		9.3.4.2	Lightweight Aggregates	9-31	
		9.3.4.3	Wood Fiber	9-31	
		9.3.4.4	Scrap (Rubber) Tires	9-31	
		9.3.4.5	Light Weight Cellular Concrete	9-31	
		9.3.4.6	Toe Berms and Shear keys	9-32	
9.4	Settlem	ettlement Mitigation			
	9.4.1	_	tion Using Wick Drains	9-32	
	9.4.2		tion Using Surcharges	9-33	
	9.4.3	Lightwei		9-34	
	9.4.4	Over-exc		9-34	
9.5	Constru	action Cons	iderations and PS&E Development	9-35	
	9.5.1		nt and Pore Pressure Monitoring	9-36	
	9.5.2	Instrume	_	9-37	
		9.5.2.1	Piezometers	9-37	
		9.5.2.2	Instrumentation for Settlement	9-38	
		,	9.5.2.2.1 Settlement Plates	9-38	
			9.5.2.2.2 Pneumatic Settlement Cells	9-38	
			9.5.2.2.3 Sondex System	9-38	
			9.5.2.2.4 Horizontal Inclinometer	9-38	
	9.5.3	PS&E Co	onsiderations	9-39	
	9.5.4	PS&E Cl		9-39	
9.6	Referei	nces		9-40	

Appendix 9-A		Examples Illustrating Staged Fill Construction Design 9-A.1 Problem Setup	9-43 9-43	
		9-A.2 Determination of Maximum Stable First Stage Fill Height	9-44	
		9-A.3 Total Stress Analysis Procedure Example	9-45	
		9-A.4 Effective Stress Analysis Procedure Example	9-51	
Chap	oter 10	Soil Cut Design		
10.1	Overvie	w and Data Acquisition	10-3	
	10.1.1	Overview	10-3	
	10.1.2	Site Reconnaissance	10-3	
	10.1.3	Field Exploration	10-4	
		10.1.3.1 Test Borings	10-4	
		10.1.3.2 Sampling	10-4	
	10.1.4	10.1.3.3 Groundwater Measurement Laboratory Testing	10-5 10-5	
40.0		· · · · · ·		
10.2		Design Considerations	10-6	
	10.2.1	Overview Design Person store	10-6	
	10.2.2	Design Parameters	10-7 10-7	
10.3		Soil Cut Design		
	10.3.1	Design Approach and Methodology	10-7	
	10.3.2	Seepage Analysis and Impact on Design	10-9	
	10.3.3	Drainage Considerations and Design	10-9	
	10.3.4	Stability Improvement Techniques	10-10	
	10.3.5	Erosion and Piping Considerations	10-11	
10.4		Excavated Materials	10-12	
10.5	Special	Considerations for Loess	10-13	
10.6	PS&E C	Considerations	10-20	
10.7	Referen	ces	10-20	
Appe	ndix 10-A	Washington State Department of Transportation Loess		
		Slope Design Checklist	10-23	
Chap	oter 11	Ground Improvement		
11.1	Overvie	w	11-3	
11.2	Develop	oment of Design Parameters and Other Input Data for Ground		
	Improve	ement Analysis	11-3	
11.3	Design 1	Requirements	11-4	
11.4	Referen	ces	11-5	

Chap	oter 12	Rock Cut Design					
12.1	Overvie	ew	12-3				
12.2	-	pment of Design Parameters and Other Input Data for Rock Cut y Analysis	12-3				
12.3	Design	Design Requirements					
12.4	Referen	nces	12-3				
Chap	oter 13	Landslide Analysis and Mitigation					
13.1	Overvie	ew	13-3				
13.2	Develo	pment of Design Parameters and Other Input Data for Landslide Analysis	13-3				
13.3	Design	Requirements	13-3				
13.4	Referen	nces	13-3				
Chap	oter 14	Unstable Rockslope Analysis and Mitigation					
14.1	Overvie	ew	14-3				
14.2		oment of Design Parameters and Other Input Data for Unstable					
		ope Analysis	14-3				
14.3	Design	Requirements	14-3				
14.4	Referen	ices	14-3				
Chap	oter 15	Abutments, Retaining Walls, and Reinforced Slopes					
15.1	Introdu	ction and Design Standards	15-1				
15.2	Overvie	ew of Wall Classifications and Design Process for Walls	15-2				
15.3	Require	ed Information	15-4				
	15.3.1	Site Data and Permits	15-4				
	15.3.2	Geotechnical Data Needed for Retaining Wall and Reinforced Slope Des	_				
	15.3.3 15.3.4	Site Reconnaissance Field Exploration Requirements	15-6 15-6				
	13.3.4	15.3.4.1 Exploration Type, Depth, and Spacing	15-8				
		15.3.4.2 Walls and Slopes Requiring Additional Exploration	15-9				
		15.3.4.2.1 Soil Nail Walls	15-9				
		15.3.4.2.2 Walls With Ground Anchors or Deadmen Anchors 15.3.4.2.3 Wall or Slopes With Steep Back Slopes or	15-9				
	1525	Steep Toe Slopes	15-10				
	15.3.5	Field, Laboratory, and Geophysical Testing for Abutments,	15-10				
	15.3.6	Retaining Walls, and Reinforced Slopes Groundwater	15-10				
	15.3.7		15-11				

15.4	General	Design Re	quirements	15-12
	15.4.1	Design M		15-12
	15.4.2	Tiered Wa		15-14
	15.4.3		Back Walls	15-14
		Walls on		15-15
	15.4.5		Embedment	15-16
	15.4.6		th Limitations	15-16
	15.4.7	_		15-17
			ility Requirements	
	15.4.8		assive, At-Rest Earth Pressures	15-18
	15.4.9	Surcharge		15-19
			Earth Pressures	15-19
		Liquefact		15-23
		Overall S	· ·	15-23
		Wall Drai	nage	15-23
		Utilities		15-24
	15.4.15	Guardrail	and Barrier	15-24
15.5			Design Requirements	15-26
		Abutmen		15-26
	15.5.2	-	ty Cantilever and Anchored Walls	15-26
			Nongravity Cantilever Walls	15-26
		15.5.2.2	Anchored/Braced Walls	15-27
		15.5.2.3	Permanent Ground Anchors	15-28
		15.5.2.4	Deadmen	15-32
	15.5.3	Mechanic	ally Stabilized Earth Walls	15-32
		15.5.3.1	Live Load Considerations for MSE Walls	15-32
		15.5.3.2	Backfill Considerations for MSE Walls	15-34
		15.5.3.3	Compound Stability Assessment for MSE Walls	15-35
		15.5.3.4	Design of MSE Walls Placed in Front of Existing Per	manent
			Walls or Rock	15-36
		15.5.3.5	MSE Wall Supported Abutments	15-38
		15.5.3.6	Full Height Propped Precast Concrete Panel MSE Wa	alls 15-40
		15.5.3.7	Flexible Faced MSE Walls With Vegetation	15-41
		15.5.3.8	Dry Cast Concrete Block Faced MSE Walls	15-41
		15.5.3.9	Internal Stability Using K-Stiffness Method	15-43
		13.3.3.7	15.5.3.9.1 K-Stiffness Method Loads and Load Factor	
			15.5.3.9.2 K-Stiffness Method Load Factors	15-51
			15.5.3.9.2 K-Stiffness Method Resistance Factors	15-53
			15.5.3.9.4 Safety Against Structural Failure (Internal	• /
			15.5.3.9.5 Strength Limit State Design for Internal S	•
			Using the K-Stiffness Method – Geosynth	etic walls 13-36
			15.5.3.9.6 Strength Limit State Design for Internal	C
			Stability Using the K-Stiffness Method –	
			Reinforced Walls	15-60
			15.5.3.9.7 Combining Other Loads With the K-Stiffr	
			Estimate of T _{max} for Internal Stability De	esign 15-64
			15.5.3.9.8 Design Sequence Considerations for the	
			K-Stiffness Method	15-64

	15.5.4 15.5.5 15.5.6 15.5.7	Prefabricated Modular Walls Rock Walls Reinforced Slopes Soil Nail Walls	15-65 15-65 15-66 15-67	
15.6	Standard	Plan Walls	15-68	
15.7	Tempora 15.7.1 15.7.2 15.7.3	Overview Geotechnical Data Needed for Design General Design Requirements 15.7.3.1 Design Procedures	15-69 15-69 15-71 15-71 15-72	
		15.7.3.2 Safety Factors/Resistance Factors15.7.3.3 Design Loads15.7.3.4 Design Property Selection	15-72 15-73 15-74	
	15.7.4 15.7.5 15.7.6	Special Requirements for Temporary Cut Slopes Performance Requirements for Temporary Shoring and Cut Slopes Special Design Requirements for Temporary Retaining Systems 15.7.6.1 Fill Applications 15.7.6.1.1 MSE Walls 15.7.6.1.2 Prefabricated Modular Block Walls	15-74 15-76 15-77 15-77 15-77	
		15.7.6.2 Cut Applications 15.7.6.2.1 Trench Boxes 15.7.6.2.2 Sheet Piling, with or without Ground Anchors 15.7.6.2.3 Soldier Piles With or Without Ground Anchors 15.7.6.2.4 Prefabricated Modular Block Walls 15.7.6.2.5 Braced Cuts 15.7.6.2.6 Soil Nail Walls 15.7.6.3 Uncommon Shoring Systems for Cut Applications	15-78 15-79 15-79 15-80 15-80 15-80 15-81	
	15.7.7	Shoring and Excavation Design Submittal Review Guidelines	15-81	
15.8	Reference	ees	15-83	
Appen	dices		15-86	
Preapp	roved Wa	all Appendices	15-87	
Appen	dix 15-A	Preapproved Proprietary Wall and Reinforced Slope General Design Requirements and Responsibilities	15-A-1	
Appendix 15-B		Preapproved Proprietary Wall/Reinforced Slope Design and Construction Review Checklist	15-B-1	
Appendix 15-C		HITEC Earth Retaining Systems Evaluation for MSE Wall and Reinforc Slope Systems, as Modified for WSDOT Use: Submittal Requirements	ed 15-C-1	
Appen	dix 15-D	Preapproved Proprietary Wall Systems	15-D-1	
		Description of Typical Temporary Shoring Systems and Selection Considerations		

Preap	proved W	all Appendix:					
	Specific	Requirements and Details for LB Foster	r Retained Earth Concrete Panel	Walls 1			
	Specific	Specific Requirements and Details for Eureka Reinforced Soil Concrete Panel Walls 1					
	Specific Requirements and Details for Hilfiker Welded Wire Faced Walls Specific Requirements and Details for KeySystem I Walls Specific Requirements and Details for Tensar MESA Walls Specific Requirements and Details for T-WALL® (The Neel Company) 51						
	Specific Requirements and Details for Reinforced Earth (RECO) Concrete Panel Walls 67						
	Specific Requirements and Details for Tensar ARES Walls						
	Specific Requirements and Details for Nelson Walls						
	Specific	Requirements and Details for Tensar W	elded Wire Form Walls	143			
Chap	oter 16	Geosynthetic Design					
16.1	Overvie	W		16-3			
16.2	Develo	evelopment of Design Parameters for Geosynthetic Application					
16.3	Design	Design Requirements					
16.4	References 16						
		Foundation Design for Signals,	gns, Noise Barriers,				
17.1	General	Bullulings		17-3			
1/.1	17.1.1	Overview		17-3			
	17.1.2	Site Reconnaissance		17-3			
	17.1.3	Field Investigation		17-3			
17.2	Founda	Foundation Design Requirements for Cantilever Signals, Strain Poles,					
	Cantilever Signs, Sign Bridges, and Luminaires - General						
	17.2.1	Design by Correlation for Cantilever S	ignals, Strain Poles, Cantilever	17. (
	17.2.2	Signs, Sign Bridges, and Luminaires	Strain Balas Contilovar Signs	17-6			
	1 / . 2 . 2	Special Design for Cantilever Signals, Sign Bridges, and Luminaires	Strain Poles, Canthever Signs,	17-9			
	17.2.3	Cantilever Signals and Strain Pole Stan	ndards	17-9			
		17.2.3.1 Overview		17-9			
		17.2.3.2 Standard Foundation Design	ns	17-10			
		17.2.3.3 Construction Consideration		17-10			

	17.2.4	Cantilever and Sign Bridges	17-11	
		17.2.4.1 Overview	17-11	
		17.2.4.2 Standard Foundation Designs	17-11	
	1705	17.2.4.3 Construction Considerations	17-11	
	17.2.5	Luminaires (Light Standards) 17.2.5.1 Overview	17-12 17-12	
		17.2.5.1 Overview 17.2.5.2 Standard Foundation Design	17-12	
		17.2.5.3 Construction Considerations	17-13	
17.3	Noise Barriers			
	17.3.1	Overview	17-13 17-13	
	17.3.4	Foundation Design Requirements for Noise Barriers	17-14	
		17.3.4.1 Spread Footings	17-14	
		17.3.4.2 Shaft Foundations	17-15	
	1722	17.3.4.3 Non-Standard Foundation Design	17-17	
	17.3.3	Construction Considerations	17-18	
17.4	Culvert		17-18	
	17.4.1 17.4.2	Overview Culvert Design and Construction Considerations	17-18 17-18	
17.5		Culvert Design and Construction Considerations		
17.5	Buildin 17.5.1	gs Overview	17-19 17-19	
	17.5.1	Design Requirement for Buildings	17-19	
17.6	Referen		17-22	
Chap	ter 18	Geotechnical Design for Marine Structure Foundations		
18.1	Overvie	ew	18-3	
18.2	Design Philosophy			
18.3	Load and Resistance Factors for Marine Structures Subject to Ship Impact			
18.4	References			
Chap	ter 19	Infiltration Facility Design		
19.1	Overvie	ew	19-3	
19.2	Geotechnical Investigation and Design for Infiltration Facilities		19-3	
19.3	References			
Chap	ter 20	Unstable Slope Management		
20.1	Overvie	ew	20-3	
20.2	References			

Chapter 21 Materials Source Investigation and Report		Materials Source Investigation and Report	
21.1	Overvie	W	21-3
21.2	Material	Source Geotechnical Investigation	21-3
21.3	Material	s Source Report	21-6
-		Geotechnical Project Development, Reports, and esign-Build Projects	22-1
22.1	Overvie	W	22-1
22.2	Definition	ons	22-1
22.3	Field Inv	vestigation Requirements for the GDR and GBR	22-2
22.4	Purpose and Content of the Geotechnical Reports Included in the Contract Documents		
22.5	Geotech	nical Memoranda and Other Reference Documents	22-8
22.6	Geotech	nical RFP Development	22-10
22.7	Geotech	nical Investigation During RFP Advertisement	22-11
22.8	Geotech	nical Support for Design-Build Projects	22-12
Appe	ndix 22-A	Example Supplemental Geotechnical Boring Program ITP Language	22-15
Chap	ter 23 (Geotechnical Reporting and Documentation	
23.1	Overvie	w and General Requirements	23-1
23.2	Report C	Certification and General Format	23-2
23.2	Geotech 23.2.1 23.2.2 23.2.3	nical Division Report Content Requirements Conceptual or Preliminary Level Geotechnical Reports Final Geotechnical Design Reports Special Reporting Requirements for LRFD Foundation and Wall Designs 23.2.3.1 Footings 23.2.3.2 Drilled Shafts 23.2.3.3 Piles 23.2.3.4 Retaining Walls	23-7 23-7 23-9 23-13 23-13 23-15 23-17 23-19
23.3	Informat 23.3.1 23.3.2 23.3.3	tion to Be Provided in the Geotechnical Design File Documentation for Conceptual Level Geotechnical Design Documentation for Final Geotechnical Design Geotechnical File Contents	23-24 23-24 23-25 23-26
23.4	Consultant Geotechnical Reports and Documentation Produced on Behalf of WSDOT		
23.5	Summar	y of Geotechnical Conditions	23-28
•		PS&E Review Checklist	23-31
• •		Typical Design Cross-Section for a Deep Foundation	23-37